Multi-Path Guided Wave Imaging for Inspection and Monitoring of Large, Complex Structures, Phase I

Completed Technology Project (2012 - 2012)

Project Introduction

There is a well-recognized need within NASA and the aerospace community at large for rapid and reliable methods for inspection of large, complex structures. This need is particularly evident for built-up aerospace components that contain multiple features such as stiffeners, ribs, cut-out and fasteners, all of which complicate existing inspection methods. Application of ultrasonic guided waves holds promise because even in such complex structures these waves have been shown to travel long distances and remain sensitive to damage. A sparse, or spatially distributed, array of simple sensors is perhaps the most effective implementation of such waves, both in terms of cost and capabilities, but the primary problem is the complexity of received signals. This complexity is caused by the unavoidable presence of reverberant, multi-path echoes that are difficult to interpret, but that also contain much more information about the structure than the simpler echoes present for a structure with few features. The proposed research will leverage the additional information contained in the multi-path signals to not only enable in situ inspection and monitoring of complex structures but also simultaneously improve the ability of a sparse array to detect and characterize damage with fewer sensors. This will be accomplished by performing a one-time measurement of the multi-path wavefield generated by each transducer in the sparse array, using this wavefield to estimate Green's functions for waves propagating from source to scatterer location to receiver, and constructing high-fidelity images by combining scattered array signals with computed Green's functions. This work is high risk but has a high payoff for NASA, the aerospace community in particular, and generally to many other applications that include civil, nuclear and petrochemical infrastructure. Successful completion could enable commercial implementation of guided wave systems for large area inspection.

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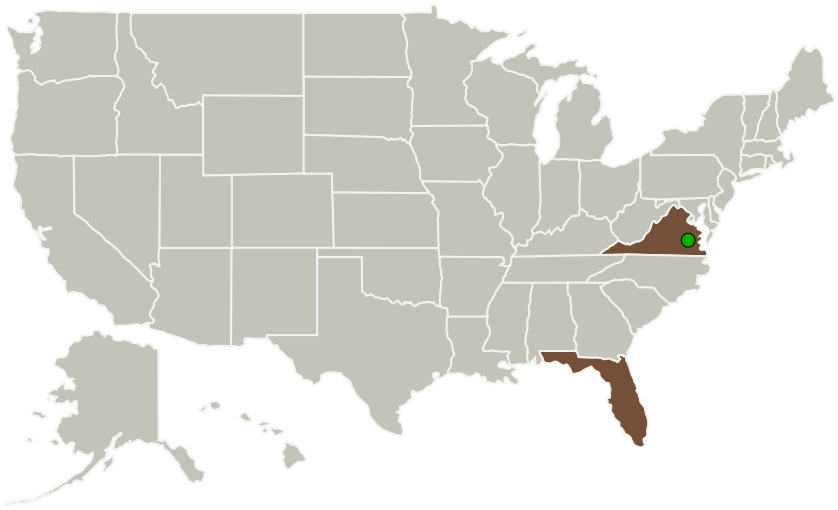
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Hidden Solutions, LLC	Lead Organization	Industry	Yulee, Florida
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Florida	Virginia

Project Transitions

February 2012: Project Start

August 2012: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138335)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Hidden Solutions, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

James Hall

Co-Investigator:

James T Hall

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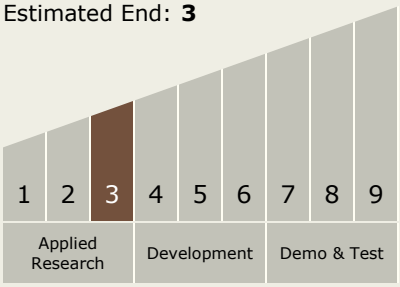
Technology Maturity (TRL)

Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.4 Manufacturing
    - TX12.4.5 Nondestructive Evaluation and Sensors

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System